

# Cardiovascular System

## I. Intro.-

- A. Function is the transportation of O<sub>2</sub>, CO<sub>2</sub>, nutrients, wastes, hormones, etc.
- B. It consists of a pump (heart) and an interconnected loop of arteries, capillaries, and veins.

## II. Layers of heart tissue – Heart needs to be stable but also to be able to move freely.

### A. Parietal pericardium

- 1. Fibrous protective sac around the heart
- 2. Has dense connective tissue that anchors the heart to the diaphragm and the sternum.

### B. Epicardium – smooth outer layer of the heart

- 1. Serous fluid lubricates b/w the epicardium and the parietal pericardium and makes it almost frictionless.
- 2. Pericarditis – when inflammation occurs b/c there is not enough serous fluid causing painful adhesions that interfere with heart movements.

### C. Myocardium – “muscle heart” – the thickest layer that contains the cardiac muscle that actually contracts.

### D. Endocardium – smooth inside lining of the heart

- 1. It is continuous with the inside lining of the connecting blood vessels.

## III. Structure of the heart

### A. Heart is a double pump that pumps in unison

- 1. The right side pumps blood into the pulmonary circulation
- 2. The left side pumps blood into the systemic circulation

### B. Atria – receiving chambers of the heart

- 1. Right atrium – receives blood from the body
- 2. Left atrium – receives blood from the lungs

### C. Interatrial septum – wall b/w the two atria

- 1. fossa ovalis – groove on septum that is a relic of the foramen ovale, a hole in the septum
  - a. foramen ovale, a hole in the septum of the fetus
  - b. allowed blood to cross over to the left side of heart since lungs were not functional

### D. Atrioventricular valves (AV valves)

- 1. Right AV valve has 3 flaps (tricuspid valve)
- 2. Left AV valve has two flaps (bicuspid valve or mitral valve)
- 3. Chordae tendineae – “tendonous cords” or “heart strings”
  - a. AV valves hang limply open when the heart is filling

- b. Pressure from filling ventricles push valves shut causing lub sound
- c. Chordae tendineae anchor the valves and keeping them from opening into atria.

E. Ventricles – pumping chambers of the heart

- 1. Left ventricle pumps to the body so much thicker than right which pumps to the lungs

F. Semilunar valves – pulmonary on rt. side, aortic on the left side

- 1. When ventricles contract, pushes SL valves open
- 2. Backflow of blood pushes them closed making “dub” sound

G. Valve problems

- 1. Incompetent valves – Congenital (at birth) or develops later.
  - a. Allows backflow of blood into atria or ventricles
- 2. Valvular stenosis – valves become stiff because of repeated endocarditis
  - a. Backflow of blood heard as heart murmurs.
  - b. Forces heart to contract more vigorously
  - c. Weakens heart and leads to heart failure
  - d. valve replacement done with synthetic valves, chemically treated pig valves, or cryogenically preserved human valves.

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H. Blood Pressure – measured in mm Hg with a sphygmomanometer

- 1. Systole – “contract” - higher blood pressure when ventricle is contracting
- 2. Diastole – “relax” – lower blood pressure when ventricle is relaxing

IV. Cardiac circulation – blood flow to the heart

A. Coronary arteries located at the base of the aorta

B. Cardiac veins empty blood into coronary sinus which runs into the right atrium.

C. Blood can only flow into heart tissue when it is relaxed,

-Rapid heartbeat can deprive heart of oxygen causing angina pectoris – crushing heart pain

-If prolonged, heart cells die from lack of O<sub>2</sub> (infarct) leading to myocardial infarction or “coronary heart attack”

V. Intrinsic conduction system (nodal system)

A. Cardiac muscles are the only muscles in the body that can contract even if all nervous system connections are severed.

- Timing of the heart muscles is controlled by the heart.

B. Sinoatrial (SA) node (pacemaker) – it starts each heartbeat and sets the pace for the heart.

-SA node triggers the atria to contract,

-signal pauses at atrioventricular (AV) node,

-then triggers the ventricles to contract.

C. Electrocardiography – measuring electric currents from the heart on the skin's surface.

-diagram showing the currents is an electrocardiogram (EKG)

D. Problems in conduction

1. Ischemia - inadequate blood supply to the heart

-may lead to fibrillation – rapid uncoordinated shuddering of the heart muscle.

- Defibrillators try to stop this fluttering so that the heart can reset a normal heart rhythm.

2. Bradycardia – heart rate of  $< 60$  beats/minute

3. Tachycardia – rapid heart rate of  $> 100$  beats/minute

Neither is pathological, but prolonged tachycardia may lead to fibrillation.

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VI. Cardiac Output (CO) – the amount of blood pumped out by each side of the heart in 1 minute.

$$\text{CO} = \text{heart rate (HR)} \times \text{stroke volume (SV)}$$

A. SV is fairly constant, but heart rate is affected by:

-Nervous system (fight-or-flight) – speeds up the heart rate

-Amount of ions such as calcium, sodium, or potassium –

-Epinephrine & thyroxine – speed up the heart rate

-Age – younger faster (140-160 bpm)

-Gender – females faster than males

-Temperature - Cold – slows heart, heat speeds it up

B. Congestive heart failure (CHF) – pumping of heart is too low to meet tissue needs for  $\text{O}_2$  and nutrients.

1. Caused by clogging up of arteries, high blood pressure, or multiple myocardial infarctions

2. Heart failure leads to pressure building up and fluids building up edema

-left side fails – pulmonary edema – fluids in lungs suffocate

-right side fails – peripheral edema - in body tissues especially hands, feet, and ankles

VIII. Differences between blood vessels

A. Arteries have thicker, more elastic walls than veins b/c blood is under more pressure in arteries.

B. The lumens(space) of veins are larger than arteries.

C. Veins have one-way valves in them that prevent the backflow of blood.

- D. As muscles surrounding veins contract and relax, they squeeze the blood back to the heart.
- E. Movement of lungs lowers the pressure in the thorax and allows vena cava to fill with blood.
- F. The walls of capillaries are only one cell thick to allow exchanges of gasses, nutrients, and wastes.

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- G. Varicose veins – people who stand on their feet or are inactive.
    - Blood pools, venous valves give out, and veins dilate (swell).
    - Decreased blood flow and increased chances of clots and embolism.

### VIII. Fetal circulation

- Oxygen highest in the umbilical vein
- ductus venosus – allows blood to bypass the immature liver
- Since only a little blood needs to go to lungs
  - foramen ovale lets blood go from right atrium to left atrium
  - ductus arteriosus lets blood from pulmonary artery jump into the aorta
- when born, the duct becomes the ligamentum arteriosum.

### IX. Vital signs – Respiration rate, body temperature, and:

- A. **Pulse** – pressure wave caused by the ventricles contracting – systole
  - Pulse sites are also known as **pressure points** to slow or stop blood flow.
- B. **Blood Pressure (arterial pressure)**
  - highest in arteries near the heart
  - lowest in vena cava
  - 1. Factors affecting blood pressure
    - a. **Fight or flight** - ↑ blood pressure because it causes vasoconstriction.
    - b. **Kidneys** remove more water to ↓ blood pressure,  
remove less water to ↑ blood pressure
    - c. **Temperature** – cold causes vasoconstriction which ↑ bp  
heat causes vasodilation which ↓ bp
    - d. **Chemicals** –
      - **Nicotine** – constricts blood vessels, ↑ bp
      - **Alcohol** – dilates blood vessels, ↓ bp
    - e. **Diet** – generally if diet is ↑ in **salt, saturated fats, and cholesterol**  
lead to ↑ bp
  - Atherosclerosis** - deposits of fatty plaques on the sides of the arteries  
and **arteriosclerosis** – walls of arteries become hard and inflexible

- treated by **balloon angioplasty**, **stents**, and different types of **cutters**
2. **Hypotension** - <100 mm Hg for systolic pressure
    - associated with good physical conditioning and/or old age
  3. **Hypertension** - > 140/90 blood pressure
    - called “silent killer”
    - Puts stress on the heart making it pump harder
    - Heart becomes weaker and overstretched leading to heart failure.